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ABSTRACT

A developmental project in a college psychology course has shown that the computer can be a useful instrument for individualizing student learning and testing by freeing instructors from clerical and test generation tasks. In successive stages, the computer was used for the batch generation of quizzes on each unit of the course, for on-line generation, scoring, and evaluation of quizzes. The COBOL, Coursewriter II, and FORTRAN languages were used, respectively, in the three phases. Evaluation showed that from 80% to 90% of the students completed all units and earned a grade of "A", as compared to 22% when non-individualized approaches were used with the instructors responsible for clerical tasks and test generation. Student reactions were overwhelmingly favorable, and students were able to proceed at their own individual paces. Also, the mean number of attempts to complete each unit declined over successive units for a given student. The cost, however, was relatively high ($10-30/student/quater). (LB)

A CASE STUDY IN THE USE OF COMPUTERS TO PERSONALIZE INSTRUCTION[1]

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Dissatisfaction with the traditional methods of presenting undergraduate psychology courses caused the search for a method of individualizing instruction that would enable the students to have more personal contact with the instructional staff and to proceed through the course at their own rates. This need to personalize instruction led to investigating the capability of the computer in aiding management of the individualization of instruction. One of the prime difficulties for an instructor who attempts to individualize instruction, as many of you well know, is that of keeping up with the clerical work in monitoring each student's progress through the course. Without ample clerical support, these instructors find that much of their time is taken by non-instructional activities such as grading papers, recording grades, and writing prescriptions. In the course to be described, the role of the computer was developed in three interrelated phases, any of which could be used as a model by other instructors.

The course under discussion is Psychology 311, Animal Learning, presented to advanced undergraduates at The Florida State University. The course content is divided into a sequence of ten units. Traditionally, between 25 and 100 students are enrolled in the course each quarter. The basic instructional program used in this course is modeled after one designed by Keller [1]. The goal of the instruction is to have each student successfully complete, at his own pace, specific oral and written objectives on each unit.

The instructional staff is organized so that for each eight students enrolled in the course, there is a student manager available for close supervision and one-to-one discussion. Organized hierarchically above the managers are the advisors, each of whom advises no more than eight managers. The advisors are in turn supervised by the instructor of the course. This hierarchical organization allows the students enrolled in the course to have an expert student or instructor available for discussion at all times.

The basic procedure used for the course at all stages of development is as follows. The students are given a study guide for the first unit on the first day of the course. Each study guide includes behavioral objectives, a brief discussion of some key concepts, supplementary information, study questions, and a list of required readings for that unit. Students are told to read the study guide before reading any of the materials for the unit. When a student feels he is ready to demonstrate his competency on all of the behavioral objectives specified in the unit study guide, he requests an oral quiz with a manager. Oral questions are used as a rapid way of evaluating whether or not a student is familiar with a unit of material and are also used to give the student an opportunity to verbalize the material. The manager orally quizzes the student on the relevant information of the unit and if the student successfully completes this oral quiz, he is then allowed to attempt the written portion of the unit evaluation. This written evaluation is composed of graph questions, identify-and-define questions that are answered in essay form, and multiple-choice and true-false questions. If the student successfully completes the written quiz, he is then given the study guide for the next unit and progresses through the same series of steps to satisfy the requirements for that unit. If the student fails to meet criterion on this written evaluation, he is given a remedial prescription by the manager. When he feels ready to make another attempt, he requests another version of the written quiz. Each student is allowed six attempts on each unit before taking a comprehensive oral quiz with the instructor.

Stage One: Batch-Generation Of Quizzes

The computer's role in the personalization of instruction at this first stage was that of generating multiple forms of unit tests. When test items are used in a course in which

[1] Presented at the 4th Conference on Computers in the Undergraduate Curricula, Claremont, California, June, 1973.

students are exposed to the same test items at different times, there is ample opportunity for the slower students to have access to all or most test items prior to examination. Keller [1] has attempted to solve this problem by using mimeographed multiple test forms. However, this strategy limits the number of unique test item sequences that can realistically be given to any one class. An efficient and flexible way of alleviating this problem is to use a computer to generate individual tests so that each student test approximates a unique set of test items. A large pool of test items is generated covering the objectives of each unit.

A computer program written in the COBOL language [2] was implemented on the CDC 6400 at the FSU Computing Center to sample without replacement from a large pool of test items and print the resulting test on the line printer. This written test consisted of the course number, student name and number, instructor's and manager's names, the attempted unit number, and a listing of 9 - 11 multiple-choice, true-false, identify-and-define, and/or graph questions. On the bottom segment of each attempt was a list of the question code numbers used by the manager for scoring purposes.

For each student, the questions on each of the six computer-generated attempts for a particular unit were randomly selected without replacement from as many as nine separate question pools. All of the questions within a pool were of the same format and covered a different aspect of the assignment. For example, one question pool might consist of identify-and-define questions on review material from the preceding unit; whereas, another pool might consist of multiple-choice questions related to a particular concept from the current unit. For each unit, up to nine questions per attempt could be selected from one question pool. The generation of a complete set of six attempts for a particular student on a specific unit did not necessarily exhaust the question pool. This latter feature, together with the fact that questions were selected without replacement, meant that each computer-generated attempt approximated a combination of novel test items. There was no overlap in test items over successive attempts for any single student. The additional fact that on the average students required only two attempts per unit resulted in little if any overlap in items across student attempts.

In addition to rapidly generating unique attempts for each student, this method of test construction was extremely flexible. Since each item was punched on an individual computer card, specific test items could be easily removed, added, or revised without influencing other items. Finally, the fact that each attempt was a singular combination of items attenuated biases that might have accrued from a specific ordering of items. Figure 1 presents an example of a written attempt and key generated by the system.

This use of the computer in personalizing instruction which relieves the instructor from generating tests was used in Psychology 311 from the Fall quarter, 1969 through the Spring quarter, 1971 as well as in an Introductory Psychology course (400 students/quarter) since the Spring quarter, 1971. During the Spring quarter, 1971, an attempt was made to discover a way to facilitate test scoring and monitoring students' progress in Psychology 311.

Stage Two: A Prototype For On-Line Generation, Scoring And Evaluation Of Quizzes

The test item pools were transferred via the Coursewriter II languages to the IBM 1500/1800 system in the Florida State University CAI center. A computer-managed instruction (CMI) package was developed to administer the tests and to monitor each student's progress through the course. This second stage of the development of Psychology 311 was used during the school year, 1971-72 with over 100 students. The procedure used was essentially the same as that used in the first stage, except that the written evaluation was broken into two parts: (a) graph questions and identify-and-define questions generated by batch processing at the FSU Computer Center (Stage 1); and (b) on-line computer-generated multiple-choice and true-false questions. (See Figure 2 for sample). For the second part, the student signed on to a teletype connected to the IBM 1500/1800 system. The student was then presented test items and responded in real time with his answers so as to facilitate test scoring and immediate feedback. Immediately after completing a quiz, the student was told by the computer that he had successfully met criterion for the unit or that he was to go to a manager for prescriptive suggestions in restudying parts of the unit so that he could successfully complete the quiz on the next attempt. Each student was allowed a maximum of six attempts per unit to meet the pre-specified criterion before being sent to a comprehensive oral quiz with the instructor. This on-line process was very helpful to both instructors and student managers since half of the quiz was scored and recorded by the computer. In addition, the CMI program monitoring of each student's progress, freed the instructor and student managers from clerical activities and allowed them to spend more effort and time with individual students. Course evaluation data was made readily available in terms of item analysis performed by the CMI program, and research data such as item

latencies, levels of state anxiety within the testing situation, and total test-taking latency were also readily available from the CMI program.

The IBM 1500/1800 system was designed primarily for research and development and the limited number of terminals (eight) available to students in this course pushed the testing materials toward a larger computer system.

The Current Stage: Flexible On-Line Generation, Scoring, And Evaluation Of Quizzes

Currently, the course is presented on the CDC 6500 system at the FSU Computing Center with remote teletype terminals situated in the Psychology Building. A series of programs [3] has been written in FORTRAN IV to perform many of the functions of the Coursewriter II CMI program on a computer system not designed specifically for anything but batch processing. This FORTRAN-based CMI package acts as both a computer-based testing program and also as a data management system. A system of direct-access files and indirect-access files has been created to hold the programs and student reponse data when the CMI system is in use. When not in operation, the files are stored on magnetic tapes to be used as backup files in case of computer system failure and also to relieve the load on the permanent file disc storage system.

In initiating the CMI package, multiple-choice and true-false questions with their associated responses, along with the several programs, are loaded into files via punched cards in batch processing mode. After the files have been initiated, questions may be edited, added, or deleted with the use of FORTRAN programs written for that purpose. Data on students who are to use the CMI package are loaded into a records file which may also be changed with the use of the proper program, all in batch mode.

By programming the batch-oriented computer to act as a CAI system, once the simple sign-on procedure has been mastered, the activities of the computer and its control are transparent to the student. Students are presented the quiz composed of unique sequences of test items on a teletype, respond by typing their answers, and receive feedback as to their performance. Data is collected by student and by test-item and put in files for later retrieval. This program may be set by the instructor to be available to students 24 hours a day or only during pre-specified times. The instructor may override the computer in specifying passing or failure of a specific quiz. The instructor may access the management program to obtain information of students signing on during the day, including unit number, and information of individual and all student progress during the quarter. At the end of the course a data analysis program presents information necessary for revision of test items by the instructor, a comprehensive schedule of progress for each student, and an overall class progress report. Approximately 170 students have gone through this program during the fall and winter quarters of the 1972-73 year.

Summary Of Results

The method of individualized instruction described above was evaluated at all stages in terms of the percent of students completing all course objectives, the rate at which students progressed through the course, and the students' evaluations of the course. In general, the results were comparable throughout the three phases of development in Psychology 311 as well as in the technique's extension to Introductory Psychology with 400 students/quarter. During each quarter in which the method was used in Psychology 311, 80-90% of all students mastered all ten course units and earned a grade of "A". In contrast, during the five quarters preceding the introduction of the individualized instruction in which a traditional lecture-quiz method was used (four different instructors), only 22% of the students earned a grade of "A". In all phases, the students' evaluations of the course were very favorable. For example, in response to the questions "My general reaction to the course was negative, indifferent or positive" and "After taking this course, I would like to take other courses using this technique", 93% of the responses were positive to the first question and 89% were positive to the second.

Figure 3 plots a distribution of the number of students completing each unit as a function of successive class periods during the Winter quarter, 1970. The gradual shift in the distribution during the first half of the quarter and the abrupt shift during the latter half of the quarter is typical of the results obtained during all phases of development.

Figure 4 plots the number of class sessions necessary for each student to complete 10 units during the four academic quarters, 1970. These results demonstrate that when given the opportunity to proceed through a course at their own rates, students do so.

Finally, Figure 5 plots the distribution of mean number of attempts/unit for each unit during the Winter quarter, 1970. Throughout all phases of development, the mean number of attempts/unit decreased over successive units.

Conclusion

In attempts to personalize instruction for the Psychology 311 course, the computer has proven to be a very useful instrument for individualizing pacing and testing procedures at each stage of development. Though the computer was not absolutely necessary, it facilitated instruction by freeing the instructor and his instructional support group from the task of presenting unique tests to each student on-demand. The computer acted as a test generator, test administrator, student evaluator, and data collector; and analyzed data necessary for the improvement of instruction and student evaluation of the course. The current program is transportable since it is written in FORTRAN IV, readily available on most machines, and requires only those adaptations demanded by the idiosyncratic nature of the machine to be used.

Though the course is presently relatively expensive ($10-$30/student/quarter for 3 - 6 attempts on each of 10 units presented on teletype terminals), it can be seen that computers can maximize personal interaction by relieving the instructor from evaluation duties and allowing him time to interact with individuals or small groups. As better computer software is developed, even this portion of instruction may be taken over more by simulating the human actions of the instructor.

NOTES AND REFERENCES

1. F. S. Keller, Goodbye teacher. Journal Of Applied Behavior Analysis, 1968, 1, 79-89.

2. The COROL program was written by Michael Mellos, Psychobiology, Florida State University. A copy of this program can be obtained from the Center for Computer Support of Instruction, Division of Instructional Research and Services, Florida State University, Tallahassee, Fla. 32306.

3. This program was written by Peter Tanzy. A copy of the program may be obtained from the Center for Computer Support of Instruction, Division of Instructional Research and Services, Florida State University, Tallahassee, Fla. 32306.

Fig. 1

S-STUDENT: TERRY A. JOHNSON 280924969 ATTEMPT 2 UNIT 9 PROCTOR: BARRY TRIPP
PSY 291 SEC: 9 INS: COHEN DATE: 5/31/71 NO. CORRECT: 9

CIRCLE THE LETTER THAT DESIGNATES THE BEST POSSIBLE ANSWER.

1. FOR WHICH PURPOSE WOULD HYPNOSIS PROBABLY NOT BE USED?
A) SYMPTOM REMOVAL
B) DESENSITIZATION
C) SUICIDE PREVENTION
D) DIAGNOSIS

2. ACCORDING TO THE DRIFT THEORY, SCHIZOPHRENIC INDIVIDUALS
A) SLIP VERY GRADUALLY INTO A DISTURBED STATE
B) MIGRATE TO IMPOVERISHED URBAN AREAS
C) VACILLATE SLOWLY BETWEEN THE NORMAL AND DISTURBED STATES
D) EVENTUALLY BECOME RESIGNED TO THEIR DIFFICULTIES

3. IT HAS BEEN SUGGESTED THAT PATIENTS WHO RECOVER OR IMPROVE UNDER PSYCHOANALYSIS MAY SIMPLY HAVE LEARNED TO RELAX IN RESPONSE TO THEIR PREVIOUSLY ANXIETY-PROVOKING THOUGHTS. THIS SUGGESTION IS MOST LIKELY TO BE MADE BY
A) PSYCHOANALYSTS
B) HYPNOTHERAPISTS
C) RATIONAL-EMOTIVE PSYCHOTHERAPISTS
D) SYSTEMATIC DESENSITIZATION THERAPISTS

4. LEARNING THAT ONES TROUBLES ARE NOT UNIQUE OFTEN OCCURS IN
A) TRANSFERENCE
B) BEHAVIOR THERAPY
C) GROUP PSYCHOTHERAPY
D) PSYCHOANALYSIS

IF A STATEMENT IS TRUE CIRCLE T. IF THE STATEMENT IS FALSE CIRCLE F.

5. ECLECTIC PSYCHOTHERAPY USES ANY TECHNIQUE APPLICABLE. T

6. DESENSITIZATION THERAPY WITH HUMANS SUBSTITUTES MUSCLE RELAXATION FOR PENN RESPONSES. T

7. ONE OF THE ADVANTAGES OF ALCOHOLICS ANONYMOUS IS THAT ITS SUCCESS IS INDEPENDENT OF A GROUP THERAPIST AND PEOPLE WITHOUT FURTHER INTENSIVE TRAINING MAY BE EMPLOYED AS LEADERS. T

IDENTIFY OR DEFINE EACH OF THE FOLLOWING IN TWO OR THREE SHORT SENTENCES. INCLUDE ONLY RELEVANT INFORMATION.

8. CLIENT-CENTERED THERAPY.

The type of therapy in which allowing the patient to spend the therapy hour in any way he wishes, as a means of enabling him to gain insight. The therapists gives little or no actual influence as far as advice or interpretation is concerned. It is a form of

9. SPONTANEOUS REMISSION.

This is when a "disturbed" person recovers without treatment of any kind (either on his own) It is used for comparison purposes to determine the value of actual treatment

I HEREBY PLEDGE MY WORD OF HONOR THAT I HAVE NEITHER GIVEN NOR RECEIVED ASSISTANCE ON THIS EXAMINATION. SIGNED: [illegible]

ABCDEFT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NO. WHO WHO DOT YOU DOE EVE ING ANY

C

S-STUDENT: TERRY A. JOHNSON 280924969 ATTEMPT 2 UNIT 9 PROCTOR: BARRY TRIPP
PSY EVE SEC: 9 INS: COHEN DATE: 5/31 NO. CORRECT: 9
GOAL QUESTIONS ATTEMPTED: 1

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PSYCHOLOGY 311 P.S. COHEN

WINTER, 1971

ON PORT/9119 YOU HAVE BEEN SIGNED ON

STUDENT:
BETSY BOUGHAKER
PSYCHOLOGY 311 MR. COHEN
DID YOU SUCCESSFULLY COMPLETE THE PRECEDING ATTEMPT?

A. YES
B. NO

A

ATTEMPT:
3
UNIT 4
QUESTION:

ENTER THE LETTER THAT DESIGNATES THE MOST POSSIBLE ANSWER.

000

SKINNER (1960) HAS REPORTED A SET OF EXPERIMENTS WHICH SUGGEST THAT AN OPERANT CONDITIONING PROCEDURE CAN BE USED TO CONDITION

A. SMOOTH MUSCULAR RESPONSES
B. CARDIAC MUSCULAR RESPONSES
C. GLANDULAR RESPONSES
D. ALL OF THE ABOVE

D

000

DELAYED REINFORCEMENT IS NOT AS EFFECTIVE AS IMMEDIATE REINFORCEMENT PARTIALLY BECAUSE

A. THE FORMER HAS A LONG LATENCY.
B. THE FORMER OCCURS ONLY ON AN INTERMITTENT SCHEDULE OF REINFORCEMENT
C. THE FORMER ALLOWS THE ORGANISM TO EMIT ADDITIONAL BEHAVIOR BETWEEN THE RESPONSE WE WISH TO REINFORCE AND THE ACTUAL OCCURRENCE OF THE REINFORCER.
D. NONE OF THE ABOVE.

C

000

THE NUMBER OF OPERANT RESPONSES A RAT WILL MAKE DURING EXTINCTION IS AFFECTED BY

A. SCHEDULE OF REINFORCEMENT PRIOR TO EXTINCTION
B. NUMBER OF REINFORCEMENTS PRIOR TO EXTINCTION
C. NUMBER OF PREVIOUS EXTINCTION SESSIONS
D. ALL OF THE ABOVE.

D

000

THE USUAL CUMULATIVE RESPONSE CURVE GIVING A RECORD OF AN ANIMAL'S RESPONSES

A. INDICATES TOTAL RESPONSES ON THE ORDINATE
B. INDICATES ELAPSED TIME ON THE ABSCISSA
C. NEVER INCREASES
D. ALL OF THE ABOVE

D

IF A STATEMENT IS TRUE, ENTER A. IF THE STATEMENT IS FALSE, ENTER B.

000

REINFORCING SUCCESSIVE APPROXIMATIONS TO A DESIRED FINAL RESPONSE IS CALLED "SHAPING".

A. TRUE
B. FALSE

A

000

"EXTINCTION" IS SYNONYMOUS WITH "FORGETTING".

A. TRUE
B. FALSE

B

000

RESISTANCE TO EXTINCTION IS A GOOD ESTIMATE OF THE PERSISTENCE OF THE TENDENCY TO EMIT AN OPERANT RESPONSE AFTER EXPOSURE TO AN INTERMITTENT SCHEDULE OF REINFORCEMENT.

A. TRUE
B. FALSE

B

000

REINFORCEMENT AFFECTS NOT ONLY THE FREQUENCY BUT ALSO THE PHYSICAL NATURE OR TOPOGRAPHY OF AN OPERANT RESPONSE.

A. TRUE
B. FALSE

A
YOU CORRECTLY ANSWERED
5
QUESTIONS.

YOU INCORRECTLY ANSWERED QUESTIONS
NUMBERED:

000

PLEASE GO SEE YOUR PROCTOR NOW.

YOU HAVE BEEN SIGNED OFF

WRITTEN TELETYPE ATTEMPT

WRITTEN MANUAL ATTEMPT

STUDENT: BETSY BOUGHAKER (263041031 TEST 1 UNIT 4 PROCTOR: CATHY THACKER
PSY 311 SEC. 2 DR. COHEN DATE SCORED

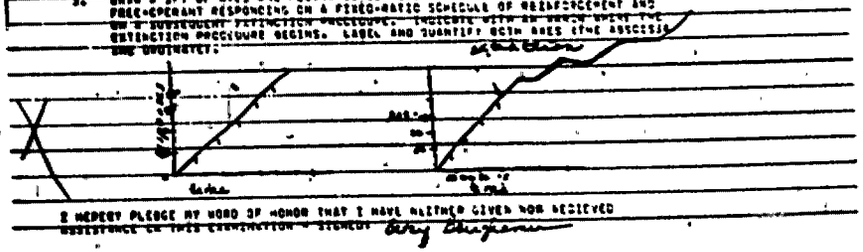
ANSWER ON BLANK EACH ITEM FOLLOWING IN THE 20 SPACE SPACE SENTENCES. INCLUDE ONLY RELEVANT INFORMATION.

1. CUMULATIVE RECORD - a record of responses is the form of a graph - x-axis is time - y-axis is responses. This is usually accomplished with the use of a cumulative recorder.

2. INTERMITTENT SCHEDULE OF REINFORCEMENT - A schedule where not every response is reinforced. Responses

MENU EACH QUESTION CAREFULLY BEFORE ANSWERING IN THE SPACE PROVIDED.

3. DRAW A SET OF AXES AND PLOT A CUMULATIVE RESPONSE CURVE THAT REPRESENTS FREE-OPERANT RESPONDING ON A FIXED-RATIO SCHEDULE OF REINFORCEMENT AND ON A SUBSEQUENT EXTINCTION PROCEDURE. INDICATE WITH AN ARROW WHERE THE EXTINCTION PROCEDURE BEGINS. LABEL AND QUANTIFY BOTH AXES (THE ABSCISSA AND ORDINATE):

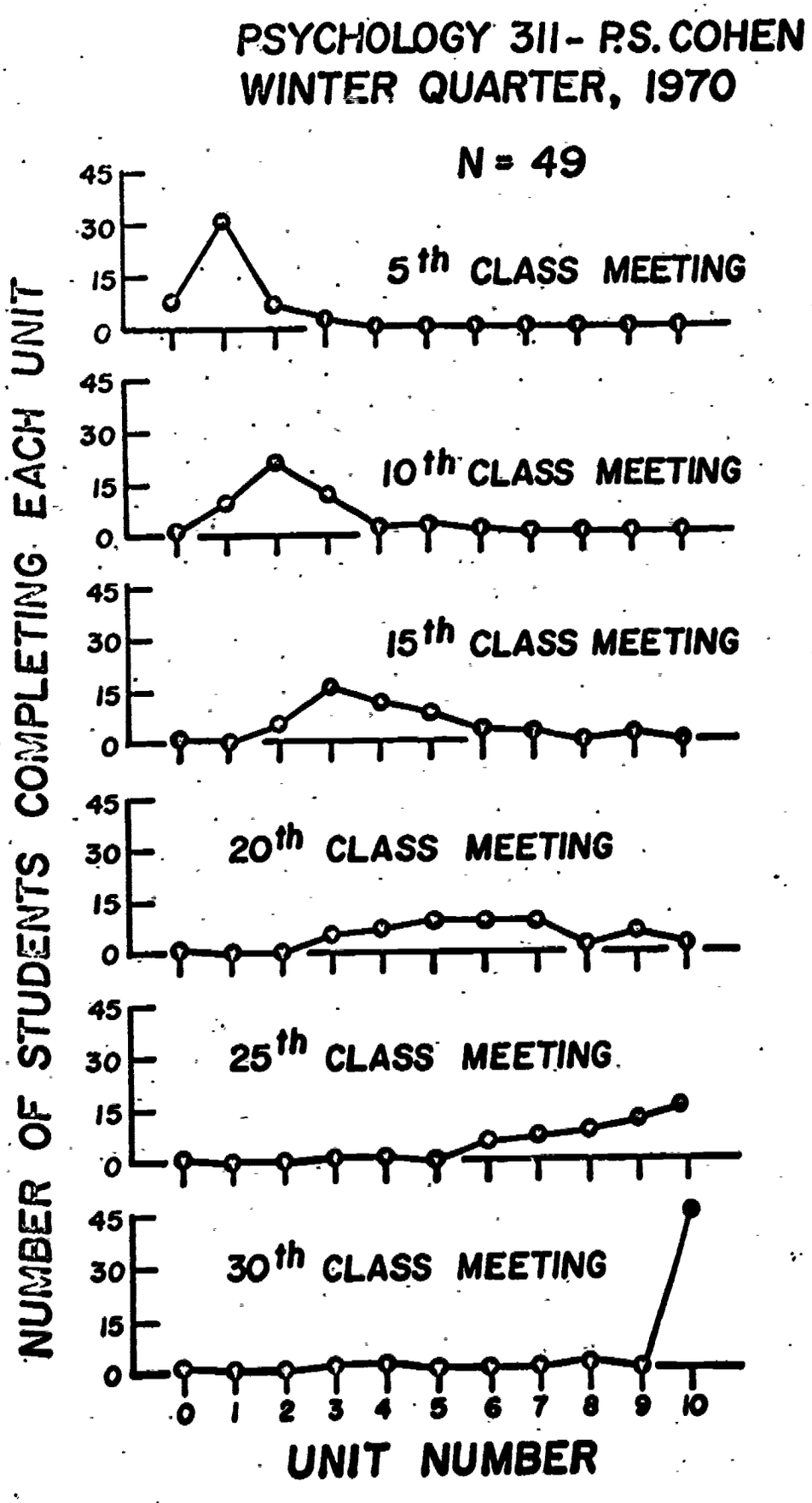


I HEREBY PLEDGE MY WORD OF HONOR THAT I HAVE NEITHER GIVEN NOR RECEIVED ASSISTANCE ON THIS EXAMINATION - SIGNED: Betsy Boughaker

PLEASE RETURN THIS QUIZ TO YOUR PROCTOR FOR SCORING IMMEDIATELY.

Fig. 2

Fig. 3


PSYCHOLOGY 311 - R.S. COHEN
WINTER QUARTER, 1970
N = 49
5th CLASS MEETING
10th CLASS MEETING
15th CLASS MEETING
20th CLASS MEETING
25th CLASS MEETING
30th CLASS MEETING
NUMBER OF STUDENTS COMPLETING EACH UNIT
45
30
15
0
0 1 2 3 4 5 6 7 8 9 10
UNIT NUMBER

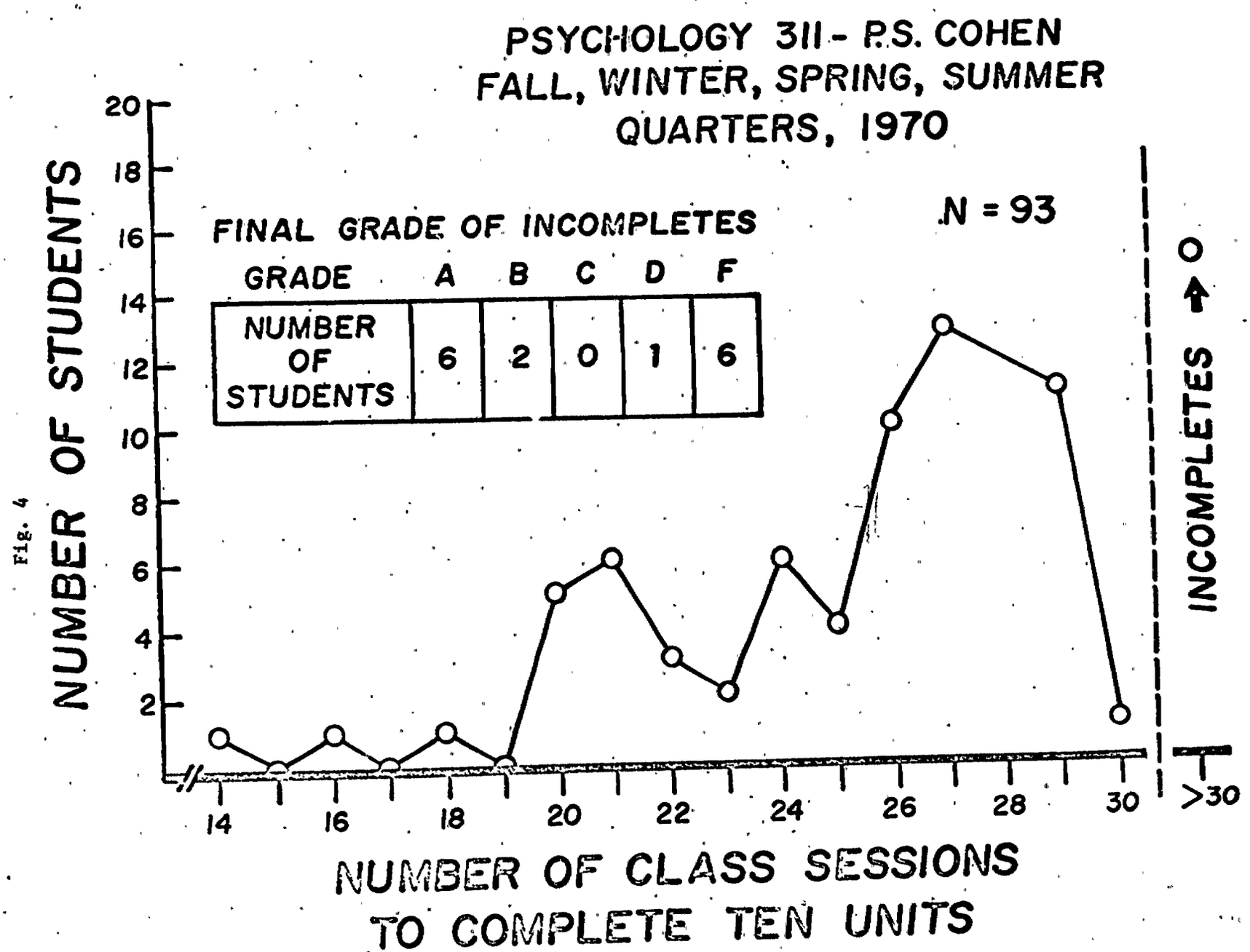
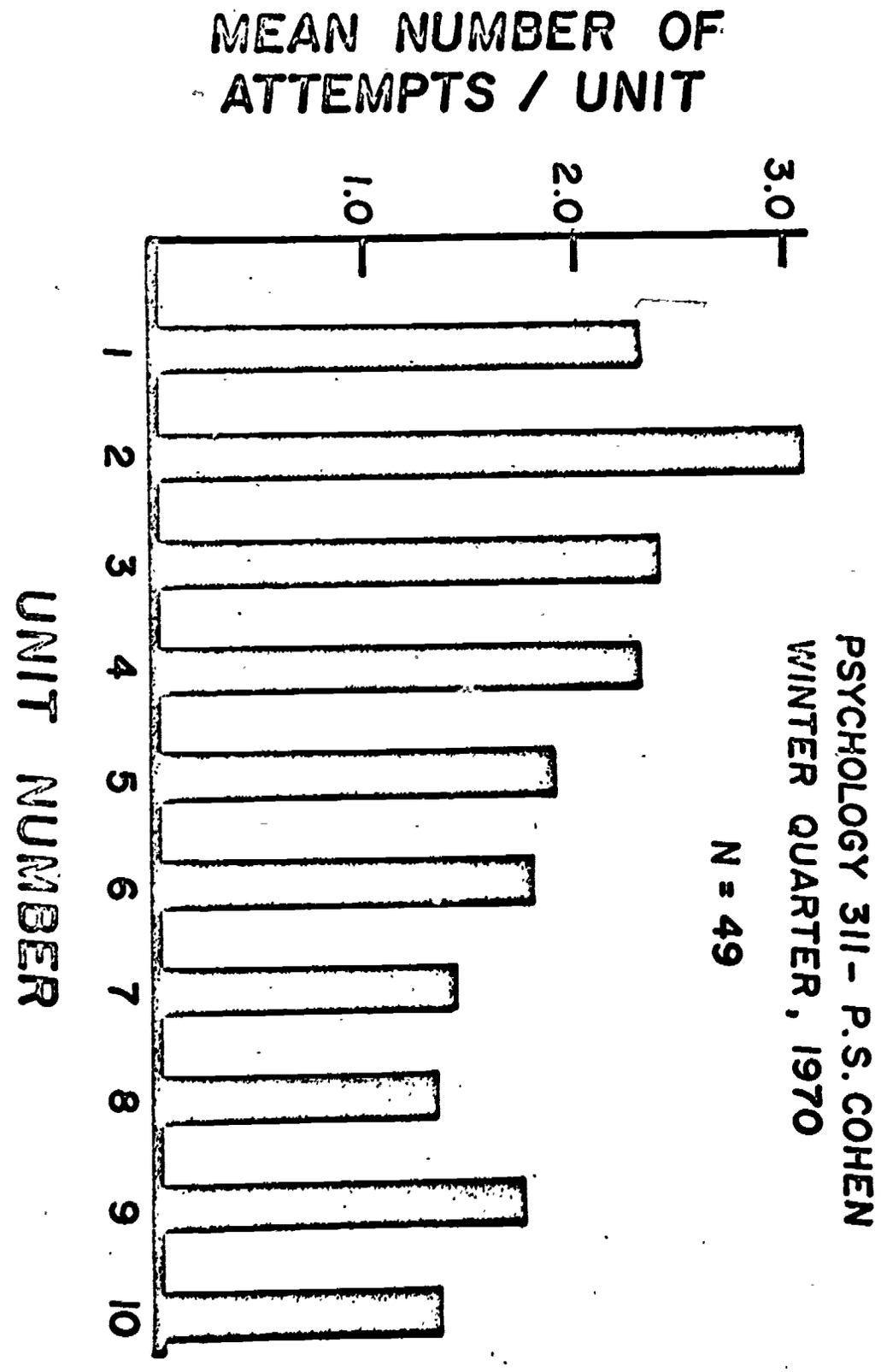

PSYCHOLOGY 311 - P.S. COHEN
FALL, WINTER, SPRING, SUMMER
QUARTERS, 1970
N = 93
FINAL GRADE OF INCOMPLETES
GRADE A B C D F
NUMBER OF STUDENTS 6 2 0 1 6
NUMBER OF STUDENTS
20
18
16
14
12
10
8
6
4
2
INCOMPLETES → 0
14 16 18 20 22 24 26 28 30 >30
NUMBER OF CLASS SESSIONS
TO COMPLETE TEN UNITS

Fig. 4

Fig. 5


MEAN NUMBER OF ATTEMPTS / UNIT
1.0
2.0
3.0
UNIT NUMBER
1
2
3
4
5
6
7
8
9
10
PSYCHOLOGY 311 - P.S. COHEN
WINTER QUARTER, 1970
N = 49